CENTRO DE CIÊNCIA E TECNOLOGIA TÊXTIL

www.2c2t.uminho.pt

Hochschule Niederrhein University of Applied Sciences

Universidade do Minho

Structure properties change of ready-to-use nonwoven wiping materials over storage time

Xinyu Song[1], Lutz Vossebein[2] and Andrea Zille[1*]

[1]2C2T-Centre for Textile Science and Technology, University of Minho, Campus de Azurém, 4800-058, Guimarães, Portugal.
[2]Faculty of Textile and Clothing Technology, Niederrhein University of Applied Sciences, Webschulstrasse 31, 41065 Mönchengladbach, Germany.

*Email: azille@2c2t.uminho.pt

Introduction

Healthcare-associated infections (HAIs) caused by the transfer of nosocomial pathogens from high-touch environmental surfaces and medical devices are responsible for significant patient morbidity, mortality and economic cost. An effective cleaning and disinfection practice plays a key role in preventing cross-contaminations and spread of HAIs. Among the most effective surface disinfection methods, the nonwoven ready-to-use disinfectant wipes are increasingly accepted for decontamination of high-touch surfaces because of its convenience and reliable performance. Though some research has been done on the effectiveness of commercial available disinfecting wipes in practical use. Whereas their behaviour during storage remains vague. This project studied the ageing of the disinfecting wipes over storage time. Chloramine as a surface disinfectant and 3 commercial wiping materials of polyester, cellulose, and their combination have been selected. The wipes before and after the contact with disinfectant solution were analysed by FTIR (Fourier-transform infrared spectroscopy) and DMA (Dynamic mechanical analysis).

Materials and methods

The tests were carried out at standard condition of 65% relative humidity (RH) and 20ºC. The surface disinfectant chloramine-t-trihydrate solution from Acros Organics® was prepared at the concentration of 10% (w/w) in distilled water. Each textile wipe sample (Table 1) was prepared with the weight of 1 g ± 0.5%. Every experiment includes a control raw sample, a control treated in water and two sample iterated with the disinfectant solution.

Table 1. Test material and variables

Surface Disinfectant: Chloramine -t trihydrate ($C_7H_8ClNO_2S.3H_2O.Na$)		
Textile substrate	**Compositon**	**Structure**
Wipe 1	100% polyester	Nonwoven hydroentangled
Wipe 2	55%cellulose/45%polyester	Nonwoven hydroentangled
Wipe 3	100% cotton	1/1 plain weave
Immersion time: 1day, 3 days, 7 days, 15 days, and 31 days		

Result and discussion

When chloramine is brought into contact with water, it slowly breaks down to generate hypochlorous acid and hypochlorite, which in turn releases chlorine and oxygen that are responsible for the bactericidal and bacteriostatic action. However, they are also strong oxidizing agents that can damage the textile fibres. It is reported that the hypochlorous acid and hypochlorite that supposed to work on the microbicidal effect diminishes when they interact with the textile substrate.

Fourier transform infrared spectroscopy (FTIR)

The ATR-FTIR spectrum of untreated W1 and W2 fabrics exhibits peaks of the polyester component (W1) and of the polyester blend (W2) at 1710 cm^{-1} assigned to stretching vibration of C=O group in ester, 1250 cm^{-1} assigned to asymmetric stretching of aromatic ester. The strong peaks in W3 at 1150, 1100 and 1020 cm^{-1} are from the vibrations of the C-O-C bond of the glycoside bridges of the cellulose structure.

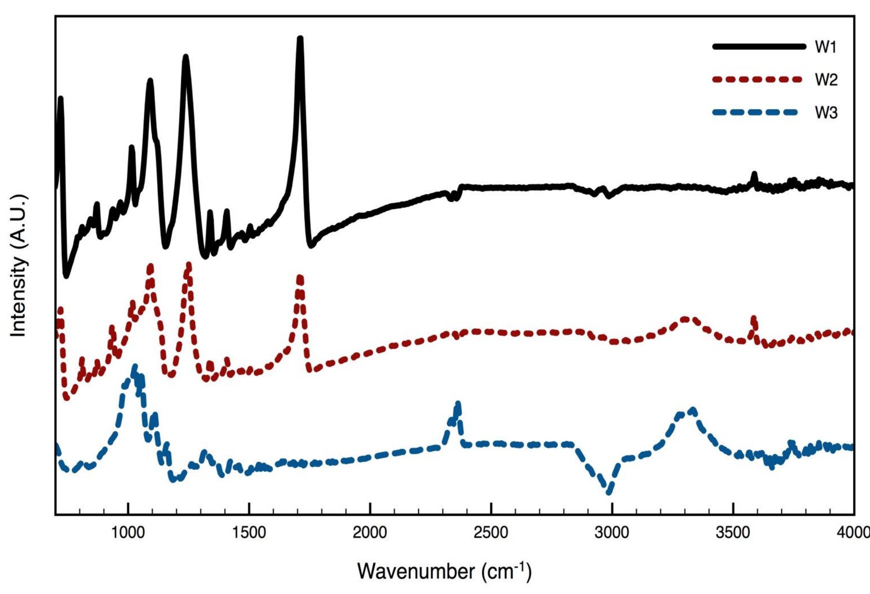

Fig. 1. ATR-FTIR spectrum of W1, W2 and W3 samples in the range 700- 4000 cm^{-1}.

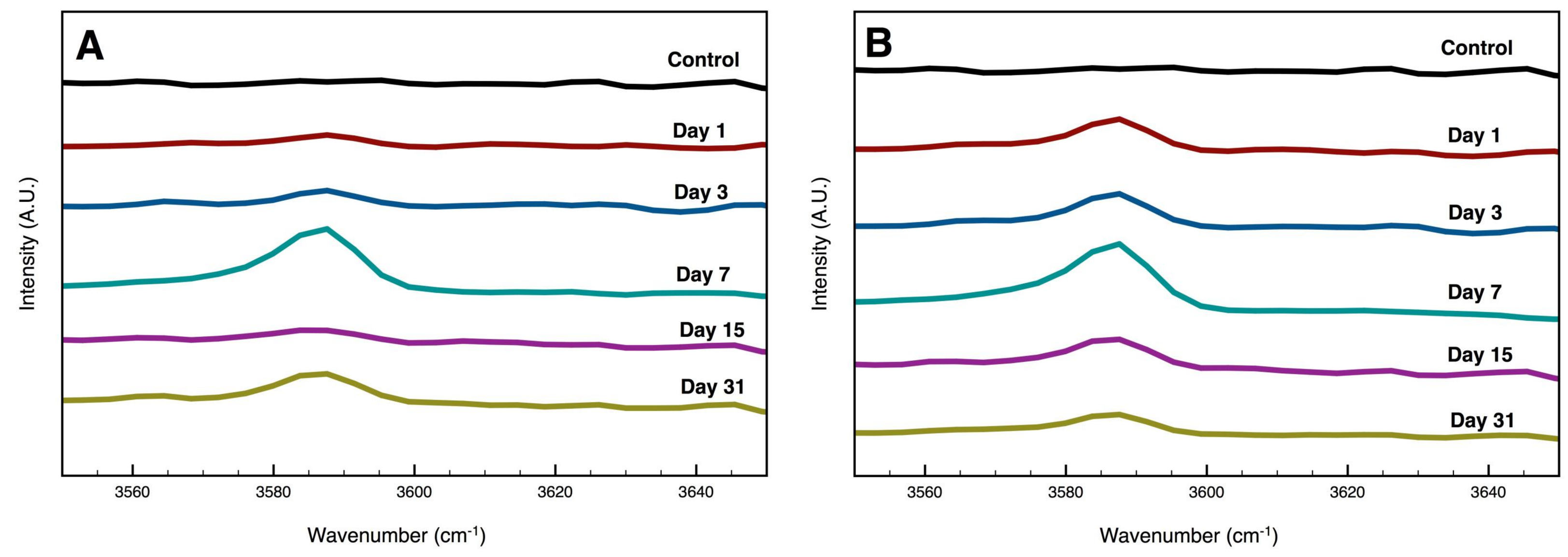

Fig. 2. FTIR spectrum of W1 (A) and W2 (B) ageing in chloramine over storage time in the range between 3550 and 3650cm^{-1}.

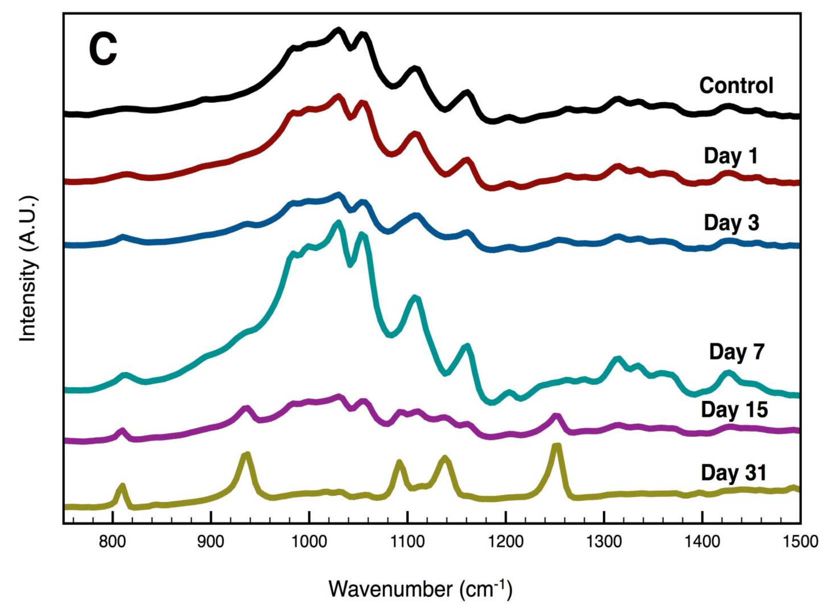

Fig. 3 FTIR spectrum of W3 (C) ageing in chloramine over storage time in the range between 700 and 1500 cm^{-1} for W3.

All the samples treated with disinfectant solution showed the formation of a new band at 3587 cm^{-1} that was attributed to the oxidation action of chloramine on the textile material. (Fig. 2-a and 2-b) The new band can be assigned to the hydroxy band –OH. W3 sample showed more changes in the FTIR spectra (Fig. 3-c) compare to the others in the oxidation of cellulose. The cellulose sample shows other changes in its chemical structure especially between 700 and 1500 cm^{-1}.

Dynamic mechanical analysis (DMA)

DMA analysis including tan delta (Fig.4), loss and storage moduli (Fig. 5) showed no changes in the mechanical properties of W1. In the W2 sample, the storage modulus compared with the samples treated in pure water decreased 98%. W3 is temperature dependent showing divergent behaviour in the water and chloramine samples. W3 is clearly the most affected in its mechanical properties by the chloramine action.

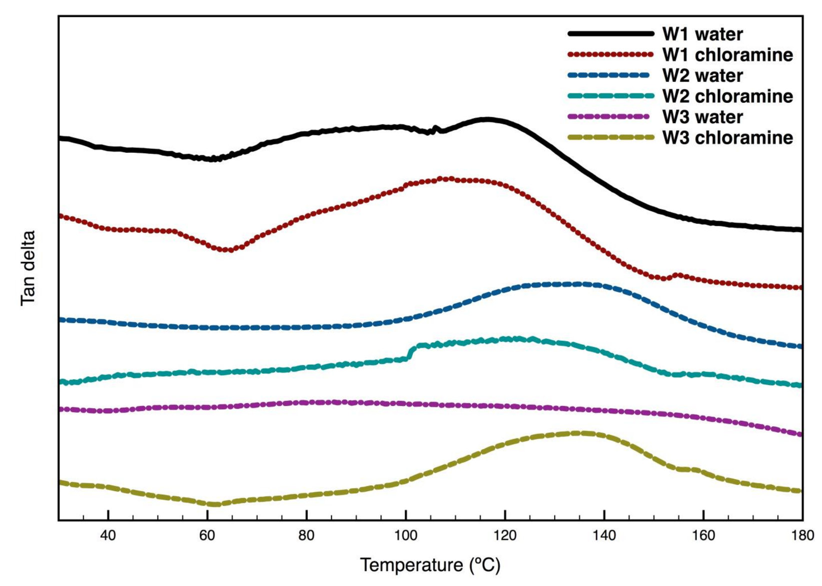

Fig 4. Temperature dependence of Tan delta of W1, W2 and W3 after 7 days of immersion in water and chloramine.

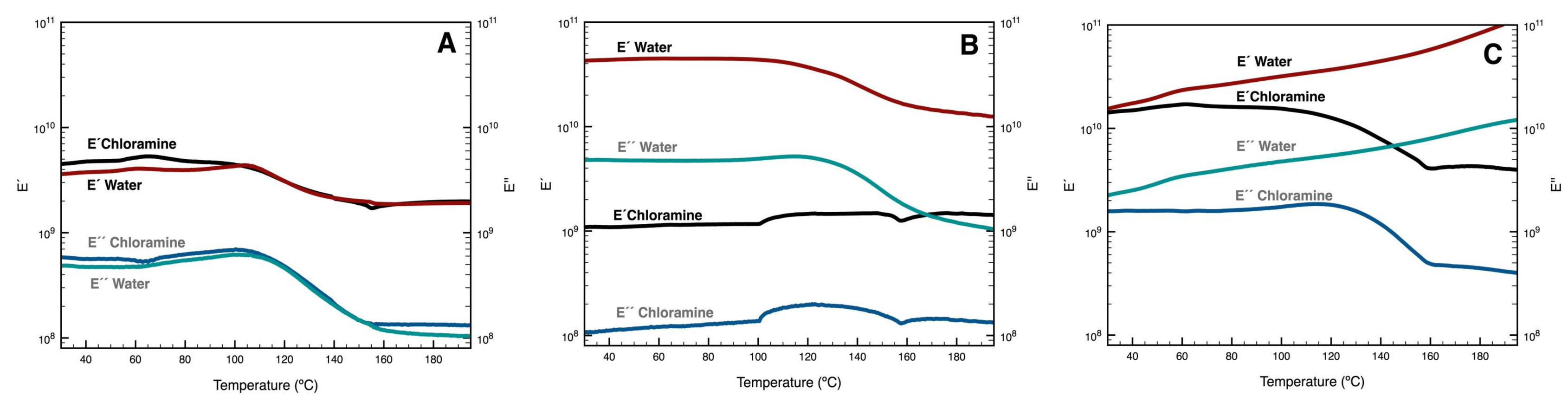

Fig 5. Temperature dependence at 4 Hz of storage (E') and loss (E'') modulus of W1 (A), W2 (B) and W3 (C) after 7 days of immersion in water and chloramine.

Conclusions

The chloramine is able to oxidize both the wipe materials with a higher action on cellulose structure then on PES. Significant change in mechanical properties was observed for cellulose-containing wipes while the PES viscoelastic properties did not show significant changes.

Acknowledgements: Xinyu Song acknowledges Fundação para a Ciência e Tecnologia (FCT), Portugal, for its PhD grant financial support (SFRH/BD/130028/2017). Andrea Zille also acknowledges FCT through the iFCT Research contract (IF/00071/2015) and the project POCI-01-0145-FEDER-007136 under the COMPETE and FCT/MCTES (PIDDAC) co-financed by European funds (FEDER) through the PT2020 program.

COMPETE QUADRO DE REFERÊNCIA ESTRATÉGICO NACIONAL UNIÃO EUROPEIA Fundo Europeu de Desenvolvimento Regional FCT Fundação para a Ciência e a Tecnologia